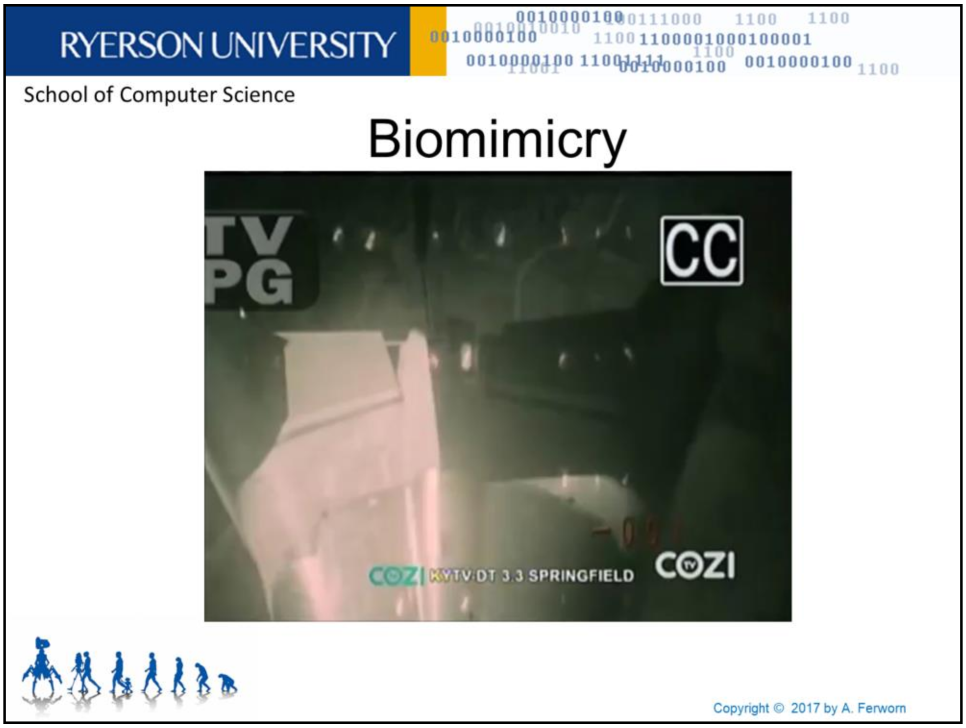

The Six Million Dollar Man is an American science fiction and action television series about a former astronaut, Colonel Steve Austin, portrayed by American actor Lee Majors. Austin has superhuman strength due to bionic implants and is employed as a secret agent by a fictional U.S. government office titled OSI. The series was based on the Martin Caidin novel Cyborg, which was the working title of the series during pre-production.

Following three television pilot movies, which all aired in 1973, The Six Million Dollar Man television series aired on the ABC network as a regular episodic series for five seasons from 1974 to 1978. Steve Austin became a pop culture icon of the 1970s.

A spin-off television series, The Bionic Woman, featuring the lead female character Jaime Sommers, ran from 1976 to 1978. Three television movies featuring both bionic characters were also produced from 1987 to 1994.

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Today

- What we do in the NCART lab: Disaster Scene Reconstruction
- Recall Behaviour-based robotics
- What is biomimicry?
  - A way to think about designing robots
- Examples of how we steal from nature
  - Burs
  - Bats
  - Termites
  - Bushbabies
  - Spiders
  - Frogs
- The future?

Haiti Earthquake 2010

20 seconds of trembling was enough to pancake this school building

USAID first responder Chris Holmes and his dog searching for survivors in Haiti. DC Fire Department employee deployed with VATF1 to Port-Au-Prince, Haiti

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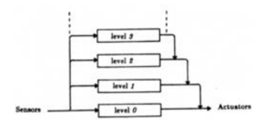
Recall: Behaviour-based Robotics (Subsumption)

- Recall Traditional Approaches to Robot Control Design
  - behavior generated after creating symbolic mental representations of the world
- Subsumption couples sensory information to action selection
- bottom-up approach
  - decompose complete behavior into sub-behaviors.
  - Sub-behaviors organized into a hierarchy of layers.
  - Each layer implements a particular level of behavioral competence
  - higher levels are able to subsume lower levels in order to create viable behaviour
- Rodney Brooks observed systems working in nature to come up with this idea
  - Biologically Inspired



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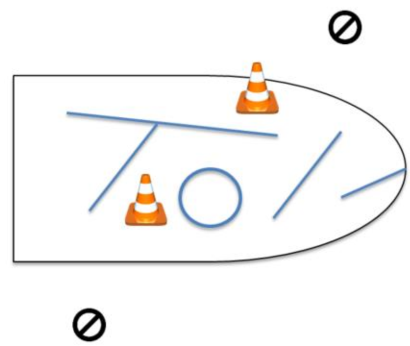
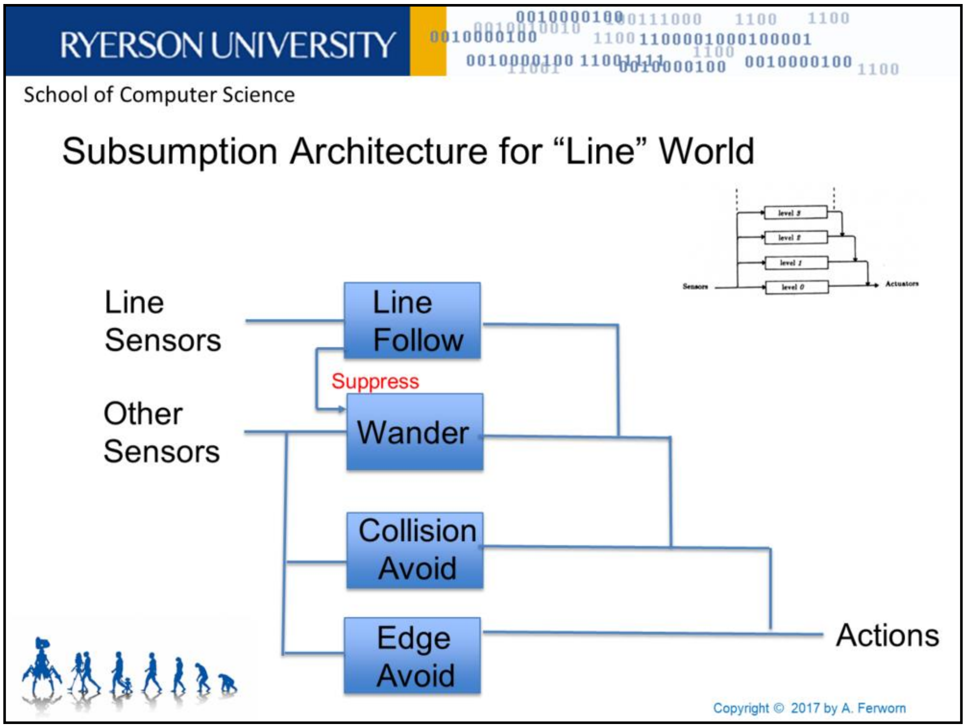
Line World

- Imagine a world consisting of
  - A flat surface of indeterminate shape
  - Objects which must be avoided
  - inescapable void around world
  - Lines that give you energy if you follow them for short periods and kill you if you keep following them

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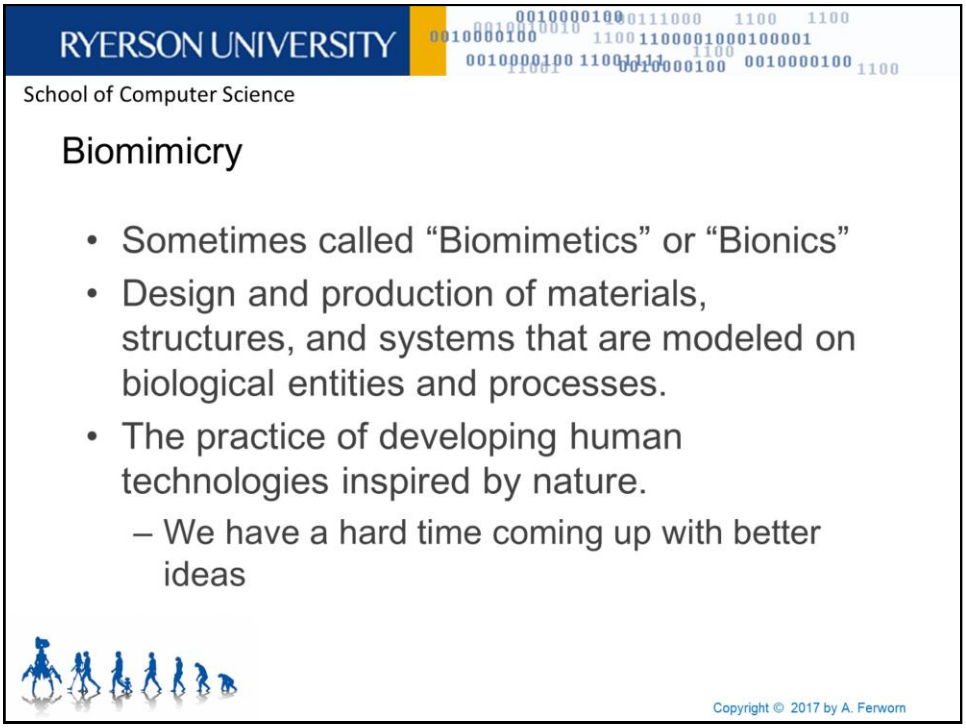
Subsumption Architecture for "Line" World
Line Sensors
Other Sensors
Line Follow
Suppress
Wander
Collision Avoid
Edge Avoid
Actions
Copyright © 2017 by A. Ferworn



Biomimetics or biomimicry is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems. A closely related field is bionics.

Living organisms have evolved well-adapted structures and materials over geological time through natural selection. Biomimetics has given rise to new technologies inspired by biological solutions at macro and nanoscales. Humans have looked at nature for answers to problems throughout our existence. Nature has solved engineering problems such as self-healing abilities, environmental exposure tolerance and resistance, hydrophobicity, self-assembly, and harnessing solar energy.

One of the early examples of would-be biomimicry was the study of birds to enable human flight. Although never successful in creating a "flying machine", Leonardo da Vinci (1452–1519) was a keen observer of the anatomy and flight of birds, and made numerous notes and sketches on his observations as well as sketches of "flying machines". The Wright Brothers, who succeeded in flying the first heavier-than-air aircraft in 1903, allegedly derived inspiration from observations of pigeons in flight.

During the 1950s the American biophysicist and polymath Otto Schmitt developed the concept of "biomimetics". During his doctoral research he developed the Schmitt trigger by studying the nerves in squid, attempting to engineer a device that replicated the biological system of nerve propagation. He continued to focus on devices that mimic natural systems and by 1957 he had perceived a converse to the standard view of biophysics at that time, a view he would come to call biomimetics.

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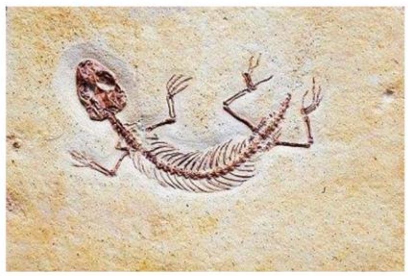
Realization

- After 3.8 billion years of research and development, failures are fossils, and what surrounds us is the secret to survival
  - – Janine M. Benyus



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Biomimetics

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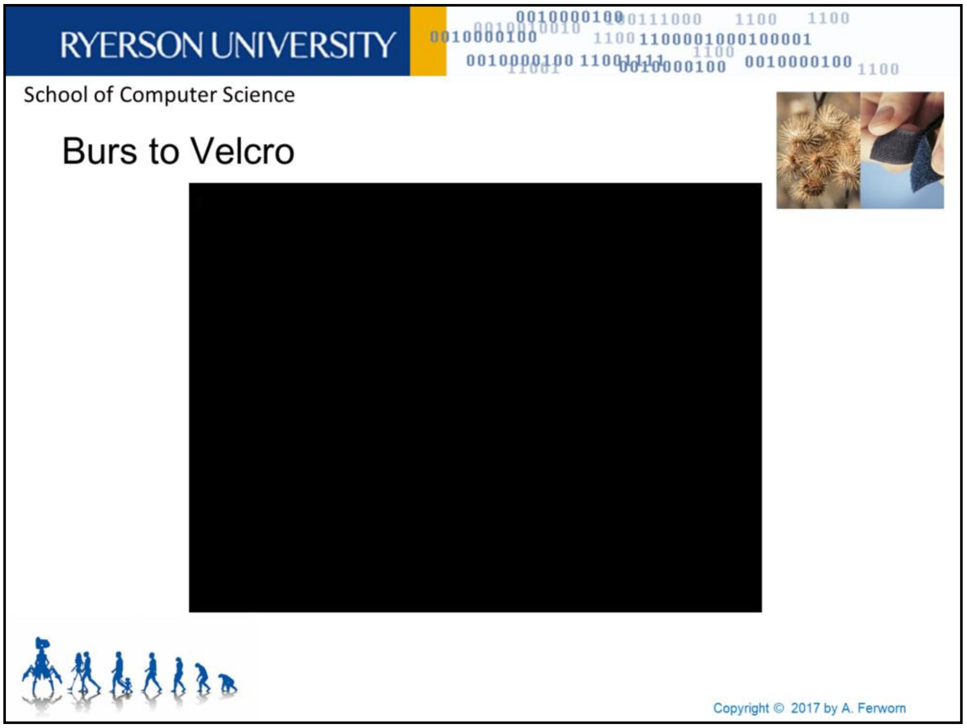
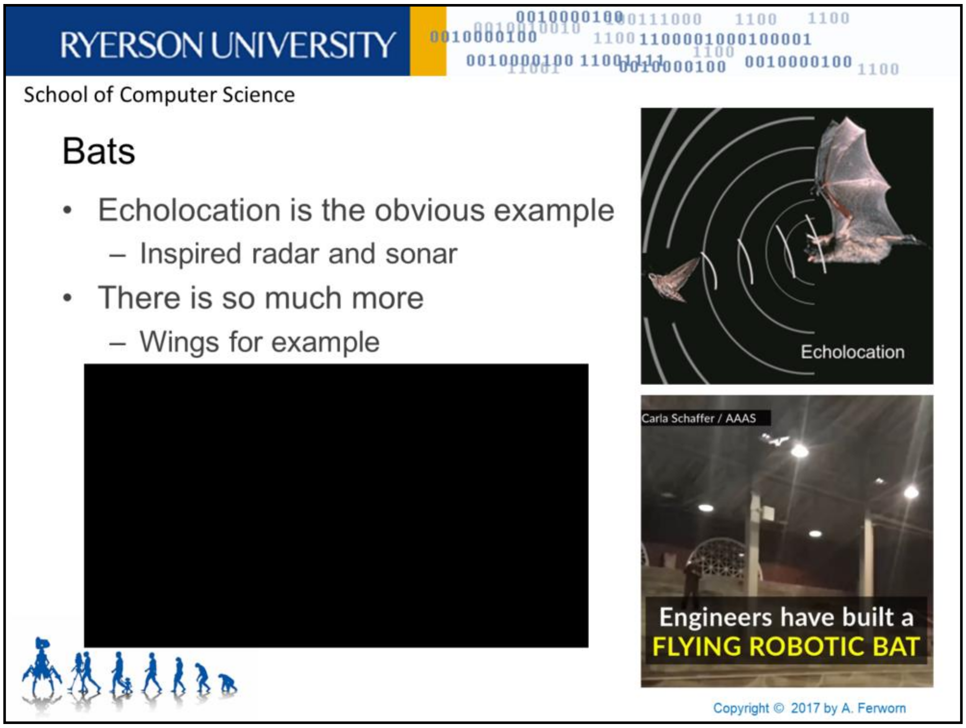
Biomimicry example (human muscles)



Velcro fastening was invented in 1941 by Swiss engineer George de Mestral, who took the idea from the burrs that stuck to his dog's hair. Under the microscope he noted the tiny hooks on the end of the burr's spines that caught anything with a loop - such as clothing, hair or animal fur. The 2-part Velcro fastener system uses strips or patches of a hooked material opposite strips or patches of a loose-looped weave of nylon that holds the hooks.



Sometimes the sense organs function under different conditions. For example, cats see well in the day but also at night. We don't see well at night and we are not that good at using our other sensors to compensate for our lack of effective night vision. Thus we fall asleep at night because there is nothing else to do.

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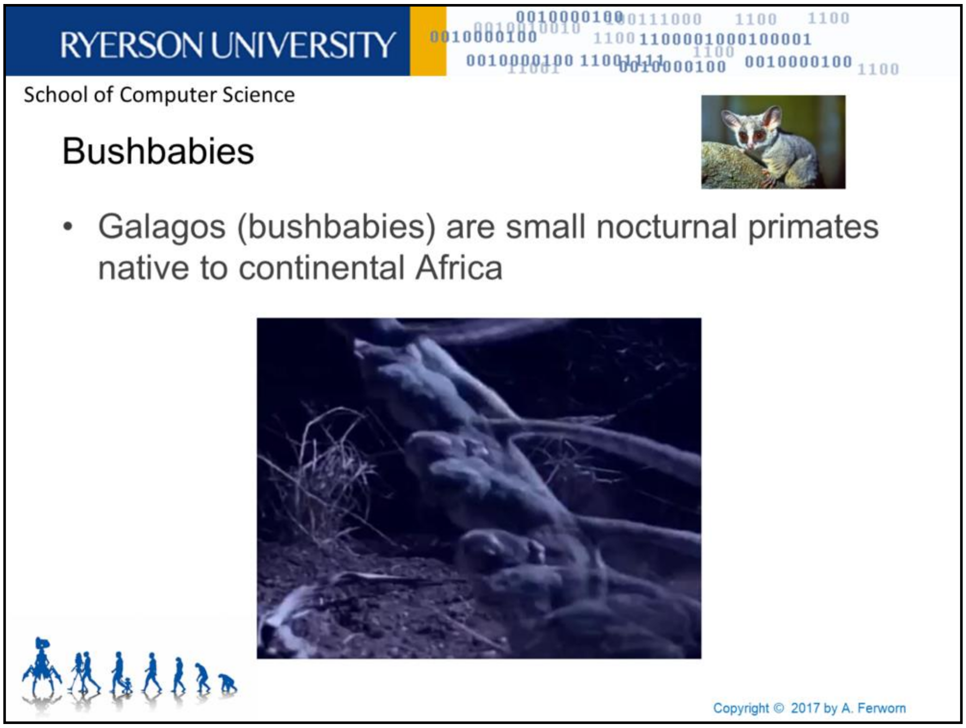
Termite Air Conditioning



Galagos have remarkable jumping abilities. The highest reliably reported jump for a galago is 2.25 m. According to a study published by the Royal Society, given the body mass of each animal and the fact that the leg muscles amount to about 25% of this, galago's jumping muscles should perform six to nine times better than those of a frog.

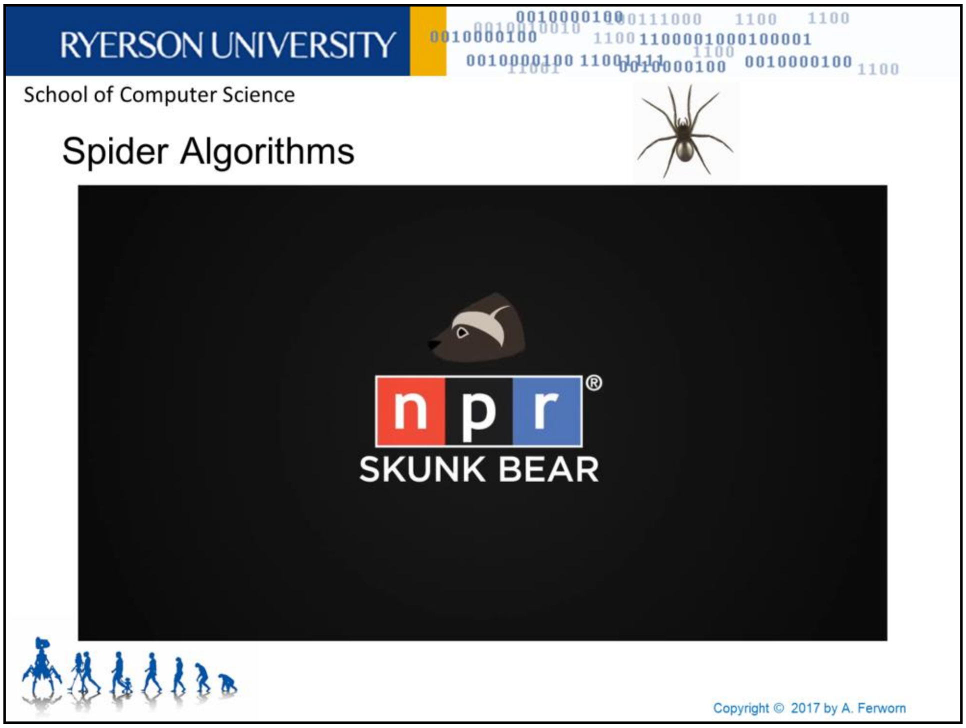
This is thought to be due to elastic energy storage in tendons of the lower leg, allowing far greater jumps than would otherwise be possible for an animal of their size. In mid-flight, they tuck their arms and legs close to the body; they are then brought out at the last second to grab the branch. In a series of leaps, a galago can cover ten yards in mere seconds. The tail, which is longer than the length of the head and body combined, assists the powerful leg muscles in powering the jumps. They may also hop like a kangaroo or simply run/walk on four legs.

Meet SALTO: a powerful new wall-jumping robot built by researchers at UC Berkeley. According to SALTO's makers, the diminutive, one-legged hopper not only has the "highest robotic vertical jumping agility ever recorded," but also the ability to link together multiple jumps in quick succession.

SALTO stands for saltatorial locomotion on terrain obstacles, and the motion of the mechanical jumping leg was modeled after galagos -- small jumping primates native to Africa that have stretchy tendons in their legs that allow them to store energy and jump with more force than if they only used their leg muscles alone. The galago is so agile not only because it can make a big leap, but also because it can essentially wind up its legs into a crouched position in mid-flight and immediately leap again upon landing. So, as soon as SALTO jumps, it is already set to jump again, which allows for what designer Duncan Haldane compared to a sort of robotic parkour:

At just 100 grams and 26 centimeters (10.2 inches) tall when fully extended, SALTO can jump a little bit more than one meter (3.3 feet) high in a single leap. Adding a second jump gets the robot up to about

1.21 meters (3.97 feet) high and while other robotic jumpers like UC Berkeley's own JumpRoACH can get higher, they still need a moment to power up before jumping again. According to Haldane, that ability to string together quick movements would make SALTO a useful tool in urban search and rescue environments [Editorial comment: This is the naïve opinion of the inventor who clearly has never seen an USAR environment] where uneven terrain and obstacles could become stepping stones.



Oxford researchers have recently discovered that the strands of silk vibrate at different sound frequencies and in different patterns, giving the spider additional details about what's going on. It works much like a string instrument. From Wired.co.uk:

The team suspects that spiders may even set out to make a web that 'sounds right' so that it can provide the information the spider needs. Evidence that supports this has been observed in the garden cross spider Araneus diadematus which, after finishing building the web, "turns around on the hub and pulls at each radial thread in some sort of sequence; in response to what she 'feels' she often readjusts a tension by reconnecting the thread to the hub mesh," explains Professor Fritz Vollrath, also from the Oxford Silk Group. "This very clearly is a process of tuning" of the overall web tensions, which affects how signal is transmitted.

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Spiders as 3D Printers

Most frogs have large protruding eyes, giving them almost 360' vision. This is needed as they don't have very flexible necks. They can see in colour and can have good vision for movement, even if far away.

Many frogs are nocturnal so have good night vision. They have a mirror layer in the back of the eye (called tapetum lucidium) that lets them reflect light at night, known as 'eye-shine'. This gives them a kind or search light for hunting by.

Deferent species have different sensitivity to light depending on their habits and habitats. This can be determined by the numbers of 'rods' and 'cones' on the frogs retina (back of the eye). Rods are sensitive to light and cones detect colour. Frogs have different colour vision to humans. They find it hard to see red light, they respond best to yellow light.

Tadpoles have eyes at the sides of their heads, but they move forward during metamorphosis. When a frog is underwater their eyes have to change because of the different refractive properties. Frogs focus by moving the lens rather then it changing shape, like in mammals.

Vision is the main sense used while hunting. Frogs have good depth and movement perception. Also because of their wide vision range they can look about without moving, so don't scare off prey. But they find it hard to see still prey.

Frogs capture prey using shear-thinning saliva that spreads over insects when the tongue hits and then thickens and sticks when the tongue retracts – according to researchers in the US. In combination with the tongue's unique material properties, this two-phase, viscoelastic fluid makes the tongue extremely sticky, allowing frogs to capture and swallow prey heavier than themselves in the blink of an eye. The research could lead to the development of new types of adhesives and material-handling technologies, say the scientists.

Frogs can capture flying insects at astonishing speeds with a flick of their whip-like tongues. But it is not just lightweight insects that they can grab. Research has shown that a frog tongue can pull up to 1.4 times the frog's body weight. And frogs have been recorded capturing larger animals such as mice and birds.

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Frogs vision and non-Newtonian spit == good eats

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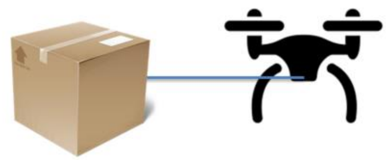
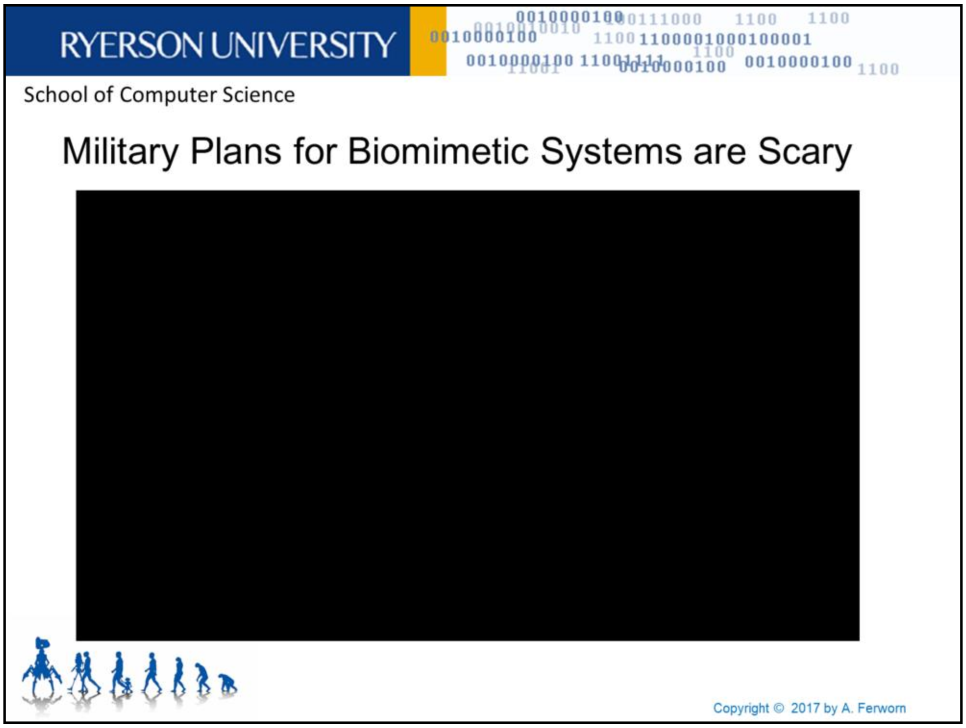
Amazon Delivery Drone Problem



What if it's not so simple to pickup a package?



US Air Force Research Laboratory video animation of a flapping-wing micro air vehicle (MAV). AFRL's goal is to develop a bird-sized MAV by 2015 and an insect-sized MAV by 2030. The bird-sized MAV would be air-deployed from a larger UAV so search for weapons of mass destruction, operating semi-autonomously for up to a week.